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How to solve the connectivity conundrum in agriculture

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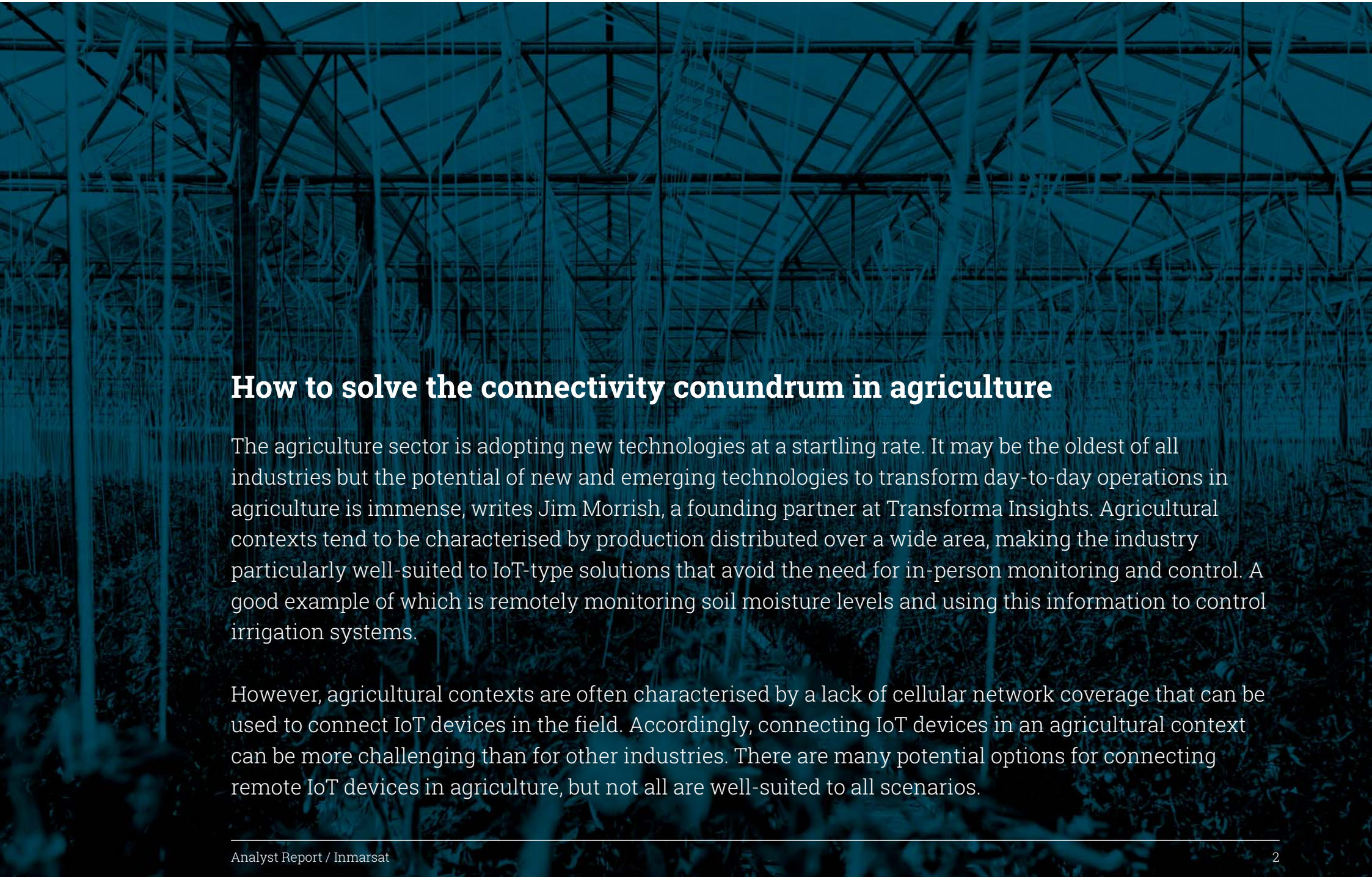

How to solve the connectivity conundrum in agriculture

The agriculture sector is adopting new technologies at a startling rate. It may be the oldest of all industries but the potential of new and emerging technologies to transform day-to-day operations in agriculture is immense, writes Jim Morrish, a founding partner at Transforma Insights. Agricultural contexts tend to be characterised by production distributed over a wide area, making the industry particularly well-suited to IoT-type solutions that avoid the need for in-person monitoring and control. A good example of which is remotely monitoring soil moisture levels and using this information to control irrigation systems.

However, agricultural contexts are often characterised by a lack of cellular network coverage that can be used to connect IoT devices in the field. Accordingly, connecting IoT devices in an agricultural context can be more challenging than for other industries. There are many potential options for connecting remote IoT devices in agriculture, but not all are well-suited to all scenarios.

The needs of the agricultural sector in terms of IoT solutions can be characterised as a combination of enterprise-type needs and consumer-type needs.

From a commercial enterprise perspective, day-to-day operations in the agricultural sector are becoming increasingly sophisticated with priorities ranging from increased efficiency to physical security and sustainability and including the need to enhance product and service offerings. These are the exact same pressures facing companies in many industries.

However, the agricultural sector is also characterised by a preference for the kind of out-of-the-box solutions that are more traditionally associated with consumer markets. Solutions ranging from tank level monitoring to crop monitoring and many others ideally need to be easy to install, intuitive to use, and robust and resilient. Adopters of such solutions often won't want to – and generally don't have the expertise to – deploy and maintain connectivity solutions specifically to support their new IoT solutions. In addition, service providers will generally prefer to control the connectivity that enables their solution in order to enable more efficient operations, including fault-resolution and better support for service level agreements.

The particular challenge for the agricultural sector is that whilst out-of-the-box connectivity is desired, agricultural contexts are often beyond the reach of the terrestrial cellular – mobile – networks that could generally be expected to support such a proposition.

What are the options for connectivity in agriculture?

As mentioned above, terrestrial cellular connectivity is generally the go-to option when a service provider wants to offer an out-of-the-box IoT proposition, but in a remote agricultural context the end-users that such a service provider is seeking to support may not enjoy good quality and consistent cellular coverage in all of the areas that they might want to deploy the solution. Coverage can, of course, be enhanced if the end-user deploys a mobile private network but currently this is a relatively complex undertaking for any end-user. For a service provider to deploy a mobile private network to support an IoT solution for an individual end-user would generally be relatively expensive and would come with the additional requirement to support the availability and functioning of that network over time.

Satellite options for IoT come in two main flavours: geosynchronous equatorial orbit or geostationary orbit (GEO) propositions, and the fast-developing low-earth orbiting (LEO) propositions. Broadly speaking, GEO satellites stay at a fixed point in the sky, whilst constellations of LEOs must work together in a coordinated way with coverage of any given point on Earth provided by whichever satellite is passing overhead at the time. In the case of sparse or incomplete constellations, the connection is provided by the satellite that will next pass overhead.

LEO services overall are garnering a lot of attention right now, although the concept of LEO-based communications networks is not new with several operators entering the market in the 1990s. Recent technological developments, not least in satellite launch technology, mean that LEO-based communication services are becoming more popular with a number of new entrants to the market. Starlink, operated by Elon Musk's SpaceX, had a constellation of more than 1,600 satellites in mid-2021. With current approval for 42,000 satellites the company has submitted filings to arrange spectrum for another 40,000. With Project Kuiper, Amazon plans to launch 3,236 LEO satellites starting in late 2022. Emerging operators Astrocast and Kinéis both aim to have their initial LEO constellations deployed and operational by early 2023. There are many more new entrants in the LEO market, and also a number of longer-established players including Telesat, Iridium and Orbcomm.

LEO services generally tend to offer global coverage and by virtue of the relatively low orbit of the satellites have the potential to offer high throughput, low latency services. However, there is an important caveat which is that transmission latencies can be long until constellations are sufficiently dense. In the case of a sparse – or partially deployed – LEO constellation a ground terminal may have to wait up to several hours, or potentially longer, until a satellite passes near enough overhead to receive data communications.

For a fuel level monitoring solution that needs to update fuel levels daily that kind of latency may be viable, but solutions such as automated irrigation might not be so tolerant of such extreme latency. An additional consideration is that the explosive growth that is currently underway in the LEO sector is likely to be followed by a wave of consolidation, and this will probably involve some failures, although some of the new entrants are likely to go on to demonstrate successful and sustainable business models.

Competition between operators with GEO fleets is relatively stable compared to the LEO situation as described above, and there are multiple long term incumbents. Examples include Avanti Communications, Eutelsat, Gilat, Inmarsat, Intelsat, SES and Viasat. GEO satellite offerings range from high speed data transfer, which is suitable for connecting a sophisticated remote networked IoT solution comprised of multiple devices and typically uses frequencies such as Ka- and Ku-band, to lower speed solutions that use frequencies such as L-band that are more similar in nature to a cellular data connection.

The distinction between L-band and K-band options is significant, since K-band services are more prone to the effects of rain fade, whereby water in the atmosphere can interfere with the propagation of satellite signals. L-band services can also be easier to install and maintain than K-band services, enabling deployment onto moving objects such as tractors, with generally lower power requirements and lower data throughput rates.

Not all GEO fleets can support global coverage, for instance Avanti Communications' fleet is focused on EMEA and Asia. The speed of light and orbiting distances from the Earth suggest that GEO latencies, the round-trip delays, should be higher than for LEO, and this is the case when comparing a GEO service with a sufficiently dense LEO constellation. However, at generally less than one second, GEO latencies compare well to the actual realised latency of a sparse LEO network, and a latency of one second is perfectly sufficient for most IoT applications.

Low power wide area (LPWA) technologies can play a significant role in supporting IoT in agricultural contexts. The main technologies in this group are the cellular technologies narrowband-IoT (NB-IoT) and LTE-M, and LoRaWAN which can be deployed either as a shared, public network, or as a private network, which is generally in licence-exempt spectrum in the case of LoRaWAN.

When deployed as public networks, NB-IoT, LTE-M and LoRaWAN all have similar coverage characteristics as described above for cellular mobile networks and may not support the required quality of coverage in a remote agricultural context. And the deployment of NB-IoT and LTE-M in private networks is subject to similar considerations as described for cellular private networks above. However, LoRaWAN can also easily be deployed as a private network in licence-exempt spectrum and it is this scenario that is particularly relevant in an agricultural context to enable the connection of multiple sensors – for instance in an orchard, or spread across multiple fields – to a single LoRaWAN gateway.

Note, however, that the LoRaWAN gateway must also be connected via a backhaul link to enable remote monitoring and control of IoT devices, with connectivity options and constraints as described above including terrestrial cellular and satellite options but also including fixed-network options, such as ADSL. Another emerging possibility is to connect direct-to-satellite using LPWA technologies, as supported for instance by Lacuna Space in LoRaWAN and Skylo in NB-IoT.

A final consideration is, of course, Wi-Fi which can be an option particularly for less sophisticated IoT solutions or in specific contexts such as horticulture. However, Wi-Fi tends to rely on end-users connecting devices to their Wi-Fi networks and on those networks functioning correctly. These are both factors that are generally outside of a solution provider's control, which can result in a sub-optimal service proposition for end-users, and an incredibly fragmented estate of deployed devices from the perspective of fault resolution by a service provider.

Optimising connectivity

So what technologies should a service provider choose to support connectivity for agricultural IoT devices in particularly remote locations?

Mobile private networks can be good in situations where connectivity is needed for a relatively high number of devices within a relatively limited geographic range, and particularly in the case that devices require high bandwidth connections, and the installation is required in a fixed location. Any requirement to reconfigure a mobile private network – for instance if it needs to be moved with a crop rotation or livestock herd – could add significant costs to this overall solution approach.

LPWA private networks particularly LoRaWAN private networks can be well-suited to situations characterised by significant numbers of low bandwidth sensors distributed over anything up to a relatively wide area, for instance monitoring within large greenhouses in the case of horticulture, or vineyards or crop monitoring.

Satellite options are relatively easy to deploy and can scale easily. Of these options L-band GEO and also LEO options are particularly well-suited to directly connecting end devices in remote agricultural locations. At generally less than around a second, latencies are insignificant in the context of most IoT applications, although latencies can be significantly higher in the case of any LEO-based operators using constellations that are either sparse or have not yet been fully deployed.

Satellite can also play a role to provide wide area connectivity for either remote mobile private networks or LPWA private networks, most commonly today in a backhaul capacity where data is aggregated at the gateway and then sent over satellite. Certain specialist providers have optimised gateways for use with satellite to achieve more cost-effective solutions.

Overall, the options for connecting IoT devices can at first seem overwhelming, and there is no single approach that is optimal for all IoT applications in all situations. But different connectivity technologies do have relatively well-defined strengths and weaknesses which can be used to help identify the ideal connectivity technology or technology combination for any specific agricultural situation. Choosing the best option(s) and building 'better' IoT solutions can be expected to secure more rapid adoption, and improved outcomes for service providers and agricultural end-users.

About Inmarsat ELERA

Inmarsat ELERA is the satellite provider's global network for the Internet of Things (IoT) and secure narrowband connectivity. Designed for mobility and trusted to connect over a million assets globally, ELERA enables the next wave of world-changing technologies that will underpin the connected society and help build a sustainable future.

ELERA is a springboard for innovation. It is accelerating pioneering use cases for commercial and government customers and is inspiring new possibilities on land, at sea and in the air. In short ELERA is:

- An L-band network with unique resilience in all conditions with complete global redundancy, ultra-high security and 99.9% availability
- Offers seamless coverage with global consistency and simple deployment in the field
- The only global geo-synchronous earth orbit (GEO) operator, with more usable spectrum in every region than any global provider, ensuring the delivery of mission-critical data
- A proven network, in operation for decades with a strong roadmap of improvements into the 2030s.

Inmarsat's Application and Solution Provider Programme (ASP) is a marketplace for IoT solutions that work anywhere. Constantly expanding, Inmarsat is working with new solution providers across agriculture, electrical utilities, mining, oil and gas, and transport and logistics.
Benefits of the ASP programme include:

- Reliable global connectivity will enable anyone to scale products and services across commercial land markets
- Gain access to expert sales and marketing support from Inmarsat and our distribution partners
- Get technical support to help get the most out of our satellite connectivity
- Access to loan hardware and development kits including modems
- The potential to create flexible and affordable data plans tailored to solution needs
- Open relationships with our developer portal
- Access and promotion to our global partner channel
- Use of the Inmarsat ASP brand in your marketing materials

Learn about the solutions Inmarsat ASP partners offer, or join the programme here:
www.inmarsat.com/ASP-Programme

Inmarsat's Application and Solution Provider Programme supports Farmbot's global expansion plans

Founded in Sydney in 2014, Australian agritech business, Farmbot, develops world-leading technology to assist food producers with remote water monitoring. Farmbot's software-as-a-service (SaaS) platform keeps farmers and ranchers "in the know" on their water assets via their smartphones or laptops, wherever they are. They benefit from near real-time reporting on water levels, trends, and alert notifications delivered via the Farmbot Monitor IoT device.

The company has grown significantly over the past few years and its core water monitoring solutions have become the new gold standard of real-time remote monitoring. Since joining Inmarsat's Application and Solution Provider (ASP) programme in the spring of 2020, Farmbot has been expanding its product offerings, and is developing new artificial intelligence (AI) smart camera systems. By collaborating with other leading agritechs and IoT developers they are to expand globally.

"I'd highly recommend other agritechs and IoT solutions providers to engage with the ASP Programme. To put it as simply, the ASP network has given us the ability to transition a concept to a fully commercialised solution in record time. It has opened doors to connect with industry experts and be placed alongside global leaders in the technology industry."

Andrew Coppin, founder and CEO,
Farmbot Monitoring Solutions

Joining the ASP Programme is an exciting step forward

Farmbot's solution centres on the Farmbot Monitor unit, a rugged, self-powering connectivity device with Inmarsat's IsatData Pro (IDP) service built-in, providing farmers and agri-businesses with essential two-way connectivity they can rely on.

Sensors connecting to the unit generate real-time alerts, trend analysis and actionable insights on water ecosystems and farm/ ranch infrastructure via proprietary algorithms. This allows farmers not only to monitor their operations, but also to control pumps and machinery remotely in real-time.

"Unreliable connectivity on terrestrial networks has previously been a key barrier to technology adoption on Australian farms," explains Andrew Coppin, founder and CEO of Farmbot Monitoring Solutions. "Although Australian farmers are some of the most innovative in the world, adoption of technology on farms has often been hamstrung by cellular connectivity issues. This connectivity challenge is not only a problem for remote farms out in the Outback, it's a huge problem all around the world, from extensive agri-businesses in some of the remotest parts of Brazil or the U.S. Midwest, through to small farms in Surrey."

Since joining Inmarsat's ASP Programme, the introduction of fast, reliable, and affordable two-way satellite communications has been a game changer and a hugely exciting step forward for Farmbot. In a world in which farmers and agri-businesses are under increasing pressure to find sustainable outcomes, reduce carbon and to produce more with less, the entire agricultural supply chain needs reliable, real-time monitoring technology to achieve these goals.

"We won't feed the world if we don't produce more food with less resources and less carbon," explains Coppin. "The global challenges are immense, the clock is ticking, and there is no silver bullet. We will need to do a whole load of incrementally smart things to achieve this."

Do you have a connectivity or distribution issue you need to solve to grow your business? Learn more about **Inmarsat's Application and Solution Provider Programme**

Unlocking the power of technology in agriculture

Farmbot has worked closely with Inmarsat to integrate the IsatData Pro (IDP) service into the Farmbot Monitor. Farmbot's applications needed remote control capability to support remote update installation, making IDP's two-way messaging capabilities particularly suitable.

"IDP has enabled us to provide our customers with all the remote farm control features we previously were only able to deliver using our cellular option," says Coppin. "We talk about it as a 'game changer' as millions of farmers worldwide now have the option of controlling their water supplies, infrastructure and other assets remotely. The technology is revolutionising the way farmers and ranchers make business decisions, unlocking exponential productivity gains, addressing sustainability goals, and boosting productivity.

"We are looking after billions of dollars-worth of livestock, and gigalitres of water and we simply cannot afford to be wrong. That's why we needed a highly reliable satellite provider to deliver critical alerts and messages back to our customers in real-time. It's all about overcoming the tyranny of distance, as well as the issues of connectivity in some of the remotest regions on earth. With IDP, we have the great functionality of two-way comms."

Farmbot's North American offering is rolling out in 2022 and is currently running a pilot program in California and Texas. Interested parties in agribusiness, technology, or distribution partners in North America please contact: **service@ranch-bot.com**

Opening up a world of new possibilities

Bi-directional satellite communications have enabled Farmbot to go beyond simply monitoring water supplies and agricultural infrastructure, giving farmers the option of controlling it, in regions of limited to no traditional connectivity. The technology opens up a range of solutions that were not previously possible by allowing equipment to be controlled on demand from anywhere on the globe. Cameras, pump controls, valves, irrigation systems and more can all now be integrated into Farmbot's system which is launching its product under the Ranchbot name in the USA in early 2022.

Farmers and agri-businesses are notoriously cost-sensitive, and one of the biggest challenges Farmbot faced prior to joining the ASP Programme, was developing a solution that would allow its monitors to take images on request at an affordable price.

"Inmarsat's ASP Programme not only provided us with the initial ISP development kit using the OGI modem, it also provided free data to perform extensive testing to develop the solution. This was invaluable to rapidly integrate this service into the Farmbot Monitor," explains Coppin, "Inmarsat worked with us to create flexible and affordable data plans for standard monitoring functionality, with the option to scale-up as cost-effectively as possible to the larger data plans required for our image-on-request camera solution."

The ASP Programme opens doors to an invaluable, global network of technical and commercial experts for IoT solutions providers such as Farmbot, helping them to join the dots and creatively connect with innovators working in different areas, from sensor technology through to image and video streaming solutions over low-bandwidth networks. Being part of this fast-growing network has given Farmbot the potential to significantly improve the management of critical water resources for farmers worldwide, resulting in tangible productivity gains, carbon reduction and ultimately, more sustainable outcomes.